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Evaluation of carotid arteries with colour doppler sonography

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Abstract: *This study designed to evaluation of carotid arteries with colour doppler sonography, were the data consisted of 130 patients (71 male and 59 female), 11 variable were used to collect the data for each of them they include; Systolic blood pressure (SBP), Diastolic blood pressure (DBP), Body Mass Index (BMI), Heart Rate (HR), Plasma Total Cholesterol (PTC), Plasma Total Glyceride (PTG), Right Intima Media Thickness (Rt IMT), Left Intima Media Thickness (Lt IMT), Right Resistive Index (Rt RI) and Left Resistive Index (Lt RI). And the study was in Libya, A General Electric Doppler machine used with a Hz probe.*
And the result shows that the Systolic blood pressure in respect to agegroup affected linearly by patient age, where the SBP decreases by 0.23mmHg/year starting at 134mmHg. Also this study also showed that there is a direct linear relationship between the intima media thickness and the blood flow resistive index. For the Rt carotid artery concerning the normal group the RI increases by 0.23unit/cm of intima media thickness starting at 0.5. The Lt carotid as mentioned earlier it receives outstanding pressure from the heart and that usually affected the intima media as well as the RI values which hindered the correlation between the two factors in both groups as well as with the other 11 factors that mentioned earlier. For normal group the RI index increases linearly by 0.4 unit /cm of intima media thickness starting at 0.36

Keywords: *carotid artery, color doppler, sonography, blood pressure*

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I. Introduction

Color Doppler sonography of carotid arteries forms an important part of the evaluation of extracranial insufficiency. Accurate diagnosis of hemodynamically significant stenosis is critical to identify patients who would benefit from surgical intervention. The value of a safe, noninvasive, and low-cost screening test is therefore of a great advantage. Duplex sonography combining high-resolution imaging and Doppler spectrum analysis has proved to be a popular, noninvasive, accurate, and cost-effective means of detecting and assessing carotid disease. Carotid sonography has largely replaced angiography for suspected extracranial carotid atherosclerosis [1].

If timely endarterectomy of the carotid arteries is performed, many stroke cases may be prevented. This necessitates an evaluation of the extracranial carotid artery system. Carotid conventional angiography is the gold standard for detecting the severity of carotid stenosis, but it has its own disadvantages such as it is an invasive and expensive procedure. It carries a risk from contrast medium to the patients and a certain amount of morbidity. Magnetic resonance angiography is currently developing rapidly and may ultimately give similar or better results, especially for flow quantification, though at a much higher cost. Besides estimating the degree of stenosis, the biggest advantage of sonography is its ability to characterize plaque and identify plaques with higher risk of embolization. With high-resolution ultrasound, plaque can be characterized into relative risk groups containing intraplaque hemorrhage which is thought to be a precursor for plaque ulceration [2,3].

Standard ultrasonic pulse-echo (PE) imaging generates anatomical cross-sectional images of the body (figure 1). In the case of ultrasound colour flow imaging (CFI) (known also as colour Doppler imaging), a colour map depicting movement is superimposed on the PE image (figure 2). The technique has many applications but is mainly used to image blood flow, and to a lesser extent movement of the cardiac muscle. A brief introduction to some clinical applications of CFI is given in §2. In principle, CFI techniques are similar to PE techniques in which information regarding the location of each target in the body, corresponding to each pixel in the image, is derived in the same way, i.e. from a knowledge of ultrasonic beam direction and pulse round-trip transit time, but the returning echoes are analysed in terms of Doppler shift rather than amplitude. Although the technique is often described as a Doppler technique, it does not make use of the Doppler shift on each transmitted pulse, but rather generates estimates of velocity from the phase shifts or time delays between echoes from the same sample volume during subsequent pulses. A rate of change of phase can be interpreted as a frequency shift and the velocity of the target can be calculated from this frequency shift using the same equation that is used to interpret the true Doppler shift found in continuous wave ultrasound instruments.

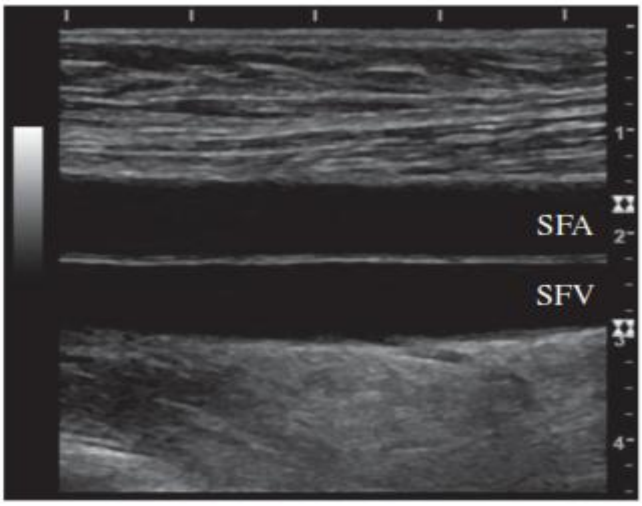

Fig 1. Pulse-echo image of the superficial femoral artery (SFA) and the superficial femoral vein (SFV) in the thigh of a healthy subject. The scan direction is vertical to generate the best view of the arterial walls. The scale to the right and the top of the image is calibrated in centimeters.

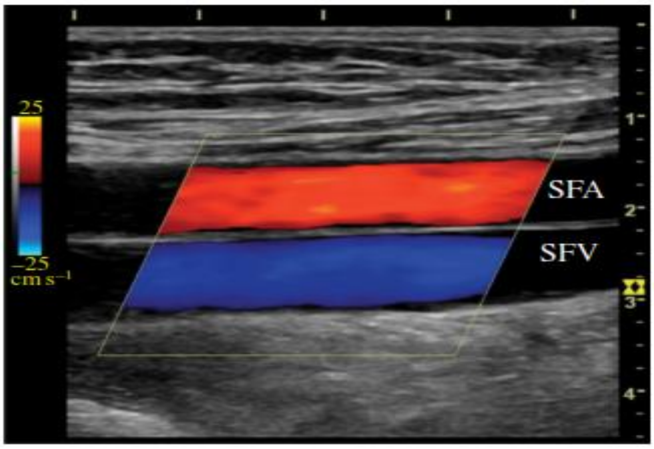

Fig 2. Colour flow image obtained by superimposing Doppler information on the pulse-echo image. The subject's head is to the left of the scan, and so the arterial flow is from left to right and the venous flow from right to left. The colour scale on the left of the image is calibrated in cm s^{-1} , and shows that flow towards the probe is coloured as red-orange-yellow, while flow away from the probe is coloured in shades of blue. Note that the area of the colour box indicating the region from which velocity information is extracted occupies only part of the image. Note also that the angle of the colour box isinclined at an angle to the vertical to ensure that the Doppler angleis different from 90^o.

Patients with Carotid atherosclerosis (CAS) normally have reduced blood pressure (BP) regulation because carotid sinus and aortic arch baroreflex play important roles in the regulation of cardiovascular reflex. The mainclinical symptoms include either too high or too low BPs with large BP fluctuation, namely increased BPV. In general, patients with CAS have the carotid intima-media thickness (IMT) more than 0.9 [4-6]. Recent study has reported that daytime and all-day (24 h) systolic blood pressure variability (SBPV) in hypertensive patients are closely related to IMT [7], and SBPV is a good predictor of IMT progression. The clinical significance of BPV has become more attractive to researchers [8-10]. However, the relationship between different BPV metrics and CAS has not been fully agreed [7,11], which requires further and comprehensive investigation.Many studies have reported that BPV is a risk predictor for organ damage, and considered that BPV is more valuable than increased blood pressure (BP), leading to the suggestion that reducing BPV is more important than lowering BP [8–10,12–14]. Recent research has also suggested that BPV is higher in hypertensive patients than in the healthy subjects [8-10]. Thus, controlling BPV has become a critical approach for BP management in hypertensive patients and patients with atherosclerotic diseases.

Method of imaging:

Two-dimensional ultrasonography

When taking short-axis view of blood vessels (transverse image), the patient is observed from the caudal side (the foot side), and the patient's right side is presented on the left side of the image obtained as one faces it. When taking long-axis view of blood vessels (longitudinal image), the direction is presented on the image obtained.

Color Doppler method

The color used for color Doppler method is red (warm color) for the blood flowapproaching the probe and blue (cold color) for the blood flow leaving the probe. This decision does not apply if a color bar is shown in the image.

Pulse Doppler method

When presenting the direction of blood flow relative to the baseline of the Doppler flow, the blood flow approaching the probe is depicted above the baseline (the positive side) while the blood flowleaving the probe, is depicted below the baseline (the negative side). This decision does not apply if the orientation of blood flow is specified on the image. Simultaneous ECG is advisable if distinction of arteries from veins or evaluation of blood flow patterns is required.

Scope of observation

Carotid artery ultrasonography covers the observation possible areas of the common carotid artery (CCA), bulbus (Bul or bifurcation; Bif), internal carotid artery (ICA) and vertebral artery (VA) on both the right and left side. As needed, the external carotid artery (ECA), sub-clavian artery (SCA), and their branch arteries may also be covered. Observation of the CCA, bulbus and ICA is indispensable when evaluation of IMC thickness (IMT: intima-media thickness) and plaques is needed.

II. Material and methods

This study was done in Libya, A General Electric Doppler machine used with a Hz probe. Water based gel, the patient's sample was 130 males and females all of them was adults. After taking a permission from the patients, patient is positioned lying face-up on the examination table. A clear water-based gel is applied to the lateral aspect of the neck, the transducer is firmly held against the skin with mild to moderate pressure. After completion of the examination the gel is rubbed off using a tissue (Fine), and the patient is asked to wait while the ultrasound images are reviewed.

III. Results

Table 1. show the mean and standard deviation of the study variables for normal and hypertensive patients

Status	Mean	Std. Deviation
Age	58.4783	4.46063
SBP	120.0087	6.25663
DBP	79.7739	3.64408
HR	79.1391	2.47051
BMI	28.6870	3.58815
PTC	151.7391	21.41346
PTG	117.3304	3.55917
RIMT	0.6474	0.02942
LIMT	0.6109	0.02214
RRI	0.6461	0.03461
LRI	0.6109	0.13941

Table 2. the mean and standard deviation of the study variables for normal respondents in respect to gender and the significance difference using t-test

Gender		N	Mean	STD	t-test value	p-value
Age	Male	71	58.00	3.014	.287	.775
	Female	59	57.85	3.028		
SBP	Male	71	120.406	4.2487	.429	.668
	Female	59	120.080	4.3843		
DBP	Male	71	79.970	2.3140	-1.984	.049
	Female	59	80.769	2.2521		
HR	Male	71	79.449	1.8194	-.947	.345
	Female	59	79.717	1.2979		
BMI	Male	71	29.438	2.3287	1.378	.171
	Female	59	28.868	2.3738		
PTC	Male	71	147.523	6.1998	.098	.922
	Female	59	147.412	6.6817		

PTG	Male	71	117.590	2.4196	-.592	.555
	Female	59	117.836	2.2724		
RIMT	Male	71	.6497	.01859	.854	.395
	Female	59	.6468	.02063		
LIMT	Male	71	.6125	.01306	-.541	.589
	Female	59	.6139	.01565		
RRI	Male	71	.6508	.02328	-.412	.681
	Female	59	.6525	.02346		
LRI	Male	71	.6165	.06172	-1.265	.208
	Female	59	.6310	.06927		

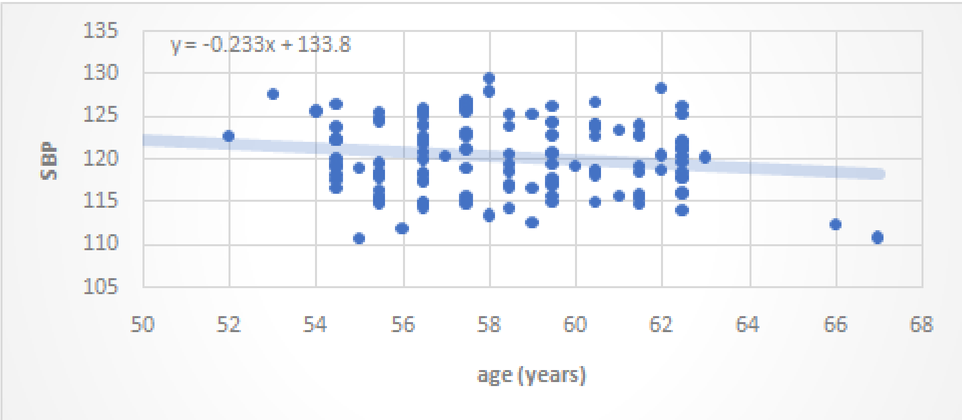

Figure 3. scatter plot shows an inverse linear relationship between age and systolic blood pressure (SBP); with SBP decreases by 0.23 mmHg/year starting at 134mmHg

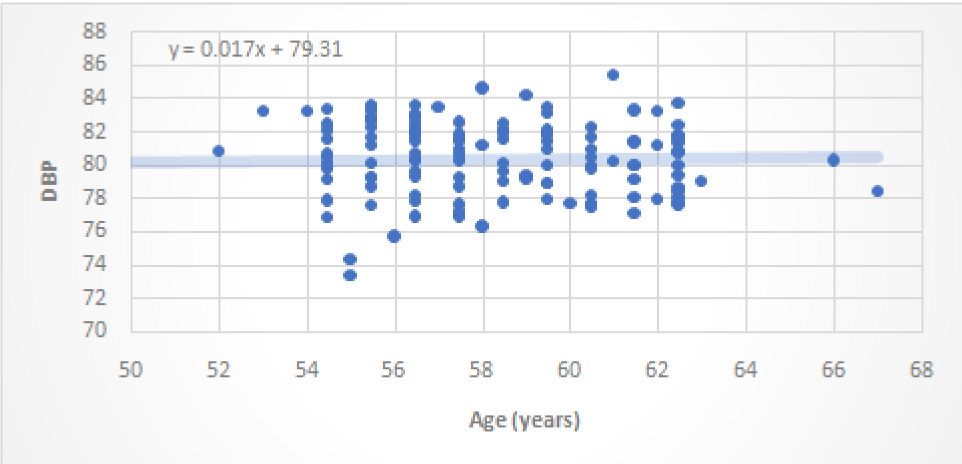

Figure 4. scatter plot shows a direct linear relationship between age and diastolic blood pressure (DBP); with DBP increase by 0.02 mmHg/year starting at 79 mmHg

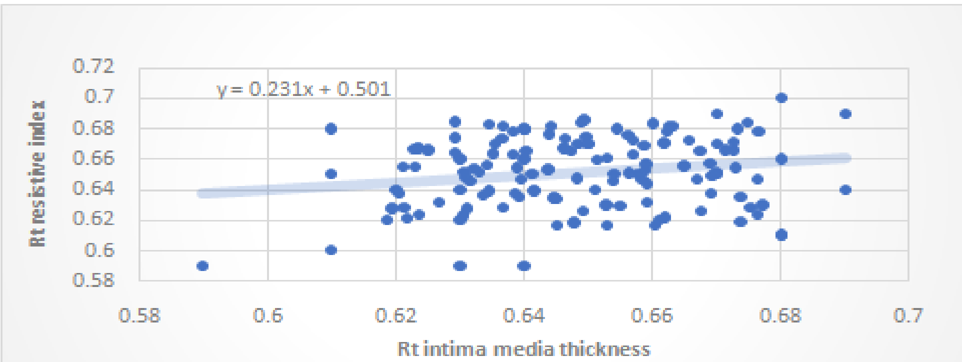

Figure 5. scatter plot shows a direct linear relationship between Rt IMT and Rt carotid artery RI; with RI increase by 0.23 unit/cm of Rt IMTstarting at 0.5 mmHg

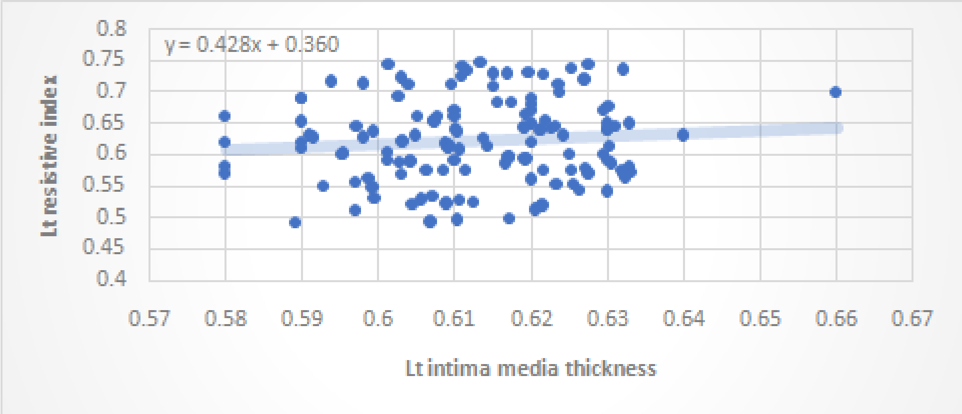

Figure 6. scatter plot shows a direct linear relationship between Lt IMT and Lt carotid artery RI; with RI increase by 0.43 unit/cm of Lt IMT for normal starting at 0.36 mmHg

IV. Discussion

The data of this study consisted of 130 patients (71 male and 59 female) where 11 variableused to collect the data for each of them they include; Systolic blood pressure (SBP), Diastolic blood pressure (DBP), Body Mass Index (BMI), Heart Rate (HR), Plasma Total Cholesterol (PTC), Plasma Total Glyceride (PTG), Right Intima Media Thickness (Rt IMT), Left Intima Media Thickness (Lt IMT), Right Resistive Index (Rt RI) and Left Resistive Index (Lt RI)

Table 1. show presented the data as mean ± STD were the results for Age, SBP, DBP, HR, BMI, PTC, PTG, RIMT, LIMT, RRI and LRI was 58.48 ± 4.46, 120 ± 6.26, 79.77 ± 3.64, 79.14 ± 2.47, 28.69 ± 3.59, 151.74 ± 21.41, 117.33 ± 3.56, 0.65 ± 0.03, 0.61 ± 0.02, 0.65 ± 0.03 and 0.61 ± 0.14 respectively.concerning the 11 factors mentioned earlier there is no significance differences between male and female in case of normal which means gender can't be consider as factor or grouping variables **Table 2.**Systolic blood pressure in respect to agegroup affected linearly by patient age, where the SBP decreases by 0.23mmHg/year starting at 134mmHg **Fig3**, The decreases conceptually was higher in the normal respondent as a value of decrease and the starting point.

This study also showed that there is a direct linear relationship between the intima media thickness and the blood flow resistive index. For the Rt carotid artery concerning the normal group the RI increases by 0.23unit/cm of intima media thickness starting at 0.5 **Fig4.** In the same fashion diastolic blood pressure (DBP) decrease as a result of age increase, for normal by 0.02mmHg/year start at 79Fig **5.**The Lt carotid as mentioned earlier it receives outstanding pressure from the heart and that usually affected the intima media as well as the RI values which hindered the correlation between the two factors in both groups as well as with the other 11 factors that mentioned earlier. For normal group the RI index increases linearly by 0.4 unit /cm of intima media thickness starting at 0.36 **Fig 6.**

V. Conclusion

The data of this study consisted of 130 patients (71 male and 59 female) to evaluatethe carotid arteries with colour doppler sonographyand the results show that there is no significance differences between male and female in case of normal which means gender can't be consider as factor or grouping variablesSystolic blood pressure in respect to agegroup affected linearly by patient age, where the SBP decreases by 0.23mmHg/year starting at 134mmHg. This study also showed that there is a direct linear relationship between the intima media thickness and the blood flow resistive index. For the Rt carotid artery concerning the normal group the RI increases by 0.23unit/cm of intima media thickness starting at 0.5.

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